Reflection of the ECER Junior Botball Workshops

Manuel Mayer
Department of Business Informatics
HTBLuVA Dornbirn
Dornbirn, Austria
manuel.mayer@student.htldornbirn.at*

Aaron Bernhart
Department of Business Informatics
HTBLuVA Dornbirn
Dornbirn, Austria
aaron.bernhart@student.htldornbirn.at**

Timo Nesensohn
Department of Business Informatics
HTBLuVA Dornbirn
Dornbirn, Austria
timo.nesensohn@student.htldornbirn.at

Michael Mayer
Department of Business Informatics
HTBLuVA Dornbirn
Dornbirn, Austria
michael.mayer@student.htldornbirn.at

Lukas Rauch
Department of Business Informatics
HTBLuVA Dornbirn
Dornbirn, Austria
lukas.rauch@student.htldornbirn.at

Julian Sonderegger
Department of Business Informatics
HTBLuVA Dornbirn
Dornbirn, Austria
julian.sonderegger@student.htldornbirn.at

** Email of the Author; ** Email of the Co-Author*

***Abstract* — Education is an integral part of preparing for the future, especially in a rapidly digitalizing and automating world. Understanding how these processes work and using them to their outmost ability will prove to be essential in the coming decades. This work describes the current state of the Austrian education system, the importance of initiatives like the ECER, the shortcomings of our hosted Junior Botball workshops and the favorable attributes of it, as well as the result and effects on the participants. The results provide evidence for the overall viability of the workshops in terms of outcome.**

I. INTRODUCTION

Education is one of the key drivers of progress, wealth and economic growth in today's day and age. In a rapidly advancing world, education and a fundamental understanding of new technology is invaluable to future generations, regardless of one's aspirations and career dreams, since robotic-based automation will become a part of any profession. Austria's education system has recognized this need and has placed a strong emphasis on integrating these subjects into its curriculum. From primary school to tertiary education, Austrian students are exposed to cutting-edge technologies and are taught the skills needed to thrive in the digital age. Competitions and educational programs like the European Conference on Educational Research (*ECER*) and the Junior Botball® initiative are filling the gaps that currently still exist within the educational system. The competitive nature of the competitions drives the students to learn independently from their mentors. Participants of the ECER Botball® competition were given an opportunity to take part in this educational campaign by introducing younger students to the exciting and thrilling world of robotics as their mentors in small workshops [7], [8]. Throughout these workshops we gained insights into the minds of young, bright children, their dreams and aspirations, their interests, and their changing views on robotics.

This Paper evaluates the findings of the Junior Botball® Workshops, puts the gathered data into perspective by comparing the average pre-workshop survey and post-workshop survey and presents the overall results.

II. STATE OF THE AUSTRIAN EDUCATIONAL SYSTEM

"An investment in knowledge pays the best interest.", is a quote from Benjamin Franklin, one of the founding fathers of the United States of America and a renowned Writer and Scientist. Learning is the single most important ability humans have. This is especially true in the face of new emerging technologies that change how humans see the world. In this section, we are taking a look at Austria's Educational system and how it integrates new subjects into its curriculum.

A. Early education

Digital schooling is growing increasingly popular in elementary schools. This trend got strongly accelerated by the Covid-19 outbreak at the end of 2019, which moved classes into homeschooling. Through these changes, schools were forced to adapt to the changing environment and integrate technology into their curriculum. For example, in an elementary school in Wolfurt, Vorarlberg, children get exposed to small robots called "*Ozobots*" [1] that are programmable to follow color-coded lines and play games. This is an excellent method to pique a child's curiosity and design classes to be more exciting and educative. Moreover, children learn arithmetic and writing on computers or tablets, as well as in conventional notebooks.
Furthermore, digital literacy has lately become a topic in lower secondary schools such as middle schools or AHS lower schools. Therefore, teachers are required to participate in seminars [2] to learn new skills that they will then pass on to their pupils. Although there is little work with robots, tablets and laptops are commonplace in middle schools and lower classes of AHS, particularly ever since the Covid outbreak. Additionally, there are multiple extracurricular subjects where students can further their education in robotic systems or information technology. Workshops are prevalent

in secondary schools and even outside of school, like the Junior Botball® workshops or the First Lego League (FLL).

B. Higher education

One of Austria's higher secondary schools' strengths in regard to robotics and information technology is the available number of resources, hardware, and software. In general, classes usually use notebooks or tablets in their everyday lessons. Additionally, STEM subjects are often taught together with robotics or information technology to allow students to connect the dots between the subjects and get an overall understanding of these topics.

However, even though the Austrian educational system has integrated robotics and IT well over the years, some schools have yet to do so. Changes might be drawn out due to a large shortage of qualified teachers. This inconsistency throughout the country can lead to disparities in educational opportunities depending on their geographic location and financial situation.
Austria's high schools have made strides in incorporating information technology and robotics into their curriculum either through voluntary extracurricular subjects or by adding them to the fixed activities.

III. Concept and Structure

The concept behind the Junior Botball® competitions [3] is designed to invite young bright minds into the world of computer science and robotics and take a hands-on approach to solving challenges. It provides a fun and engaging learning experience by letting the students work together in teams and solving small hurdles with code and their heads. The program provides sets with an assemblable clamping-blocks-based robot, which in turn can be programmed using either Python or Clang.

A. Structure content of the workshop

The workshop we hosted consisted of a series of several short input sessions that were presented up front. In addition, a large amount of hands-on training and work was provided for the students. At the beginning of the workshop, the tutors introduced themselves and presented the agenda for the day. Afterwards, information letters and cheat sheets were distributed, as well as the first pre-workshop survey and the unique Student IDs to allow the participants to fill out the survey and state their honest opinions. These student IDs were important to hand out because a comparison of the pre-workshop and post-workshop responses allows us to assess our shortcomings and strengths in order to improve our performance.

In first theoretical session basic terms and concepts that will be important for the development of a robot were clarified. Questions such as "What is a robot?", "How can we give it instructions?" and "Where are robots in our daily lives?" were important to answer before diving right into a practical example. We started with a simple driving example that introduced the kids to functions, keywords, variables, and ports. These concepts and ideas were presented through analogies to our everyday life. For example, a program can be explained using a recipe. The different ingredients are the variables you need to declare, and the amount you require is the value. With explanations like these we could present complex problems in an easy-to-grasp manner.

Within the first half-hour of the workshop, most kids were able to let the robot drive in intricate patterns and even implement loops to repeat the same movement again. This was once more explained with our analogy of baking a cake. By putting the instructions of baking a cake into a loop, you will get the amount specified in the loop condition.

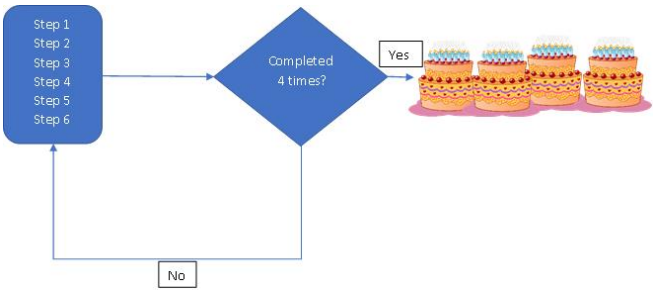

Fig. 1 A simple flow chart describing the concept of a loop and ending condition.

The second theory session took place about two hours after the start of the workshop, during which all concepts were once again explained by the children themselves. Additionally, misconceptions and issues got resolved by providing them with another explanation [6]. With these new concepts, more complex problems could be solved, such as picking up the Botgal with the gripper arm and following a black line. Since these actions require the data from sensors, we offered them guidance throughout the entire process.

At the end of the workshop the students filled out the post-workshop survey and voiced their feedback.

IV. Results

In this section, we present the findings of the workshop designed to teach children between the ages of 10 to 14 how to design robots and solve problems. The workshop was intended to provide a hands-on and entertaining environment where children could learn by doing and explore the limitless possibilities of robotics. In this section, we evaluate the effectiveness of the workshop and highlight the skills and knowledge gained by the attendees.

A. Interest in Robotics

At the start of the workshop, over 50% of the workshop participants expressed a big interest in robotics while about a quarter of students indicated a slight interest

in robotics. These numbers jumped to about two thirds of the children expressing a large interest in robotics.

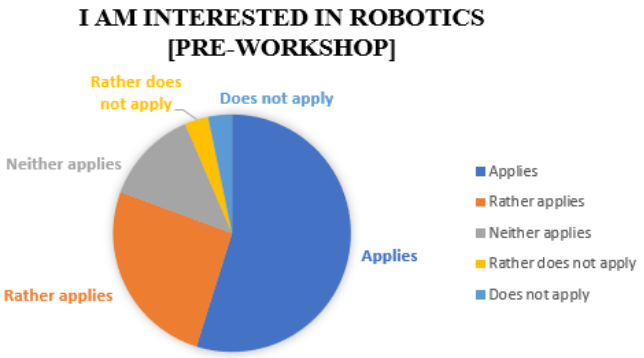

Fig. 2 Views of workshop participants before the course

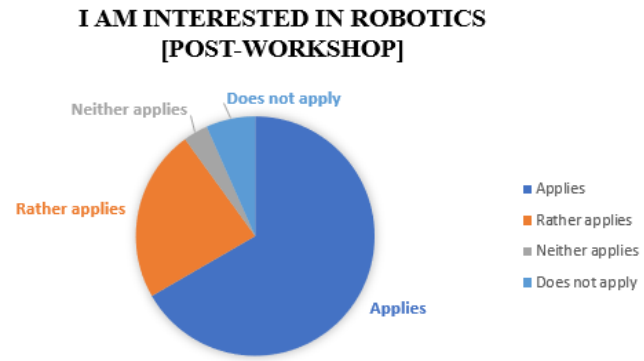

Fig. 3 Increase in interest by the workshop participants after the course ended.

This increase in popularity of robotics and engineering was only noticeable in the male attendees, where the answers generally moved from an average rating of 1.583 to a more positive rating of 1.521 throughout the workshop. The female attendees kept their initial perception at the same rate of 1.571.

B. *Understanding of robotics*

To harness the potential within new technological advancements, individuals have to reach certain understanding of it. Only with a strong fundamental knowledge, can the young brights of tomorrow use robots and automation to their advantage to streamline their productivity and remain relevant in this rapidly changing world.

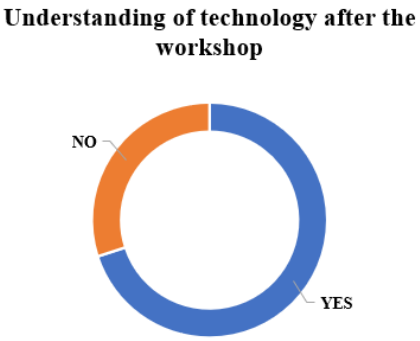

Fig. 4 Increased understanding of technology after the workshop ended. The respondents were only able to answer using Yes/No.

As seen in Fig. 4, 70% of the attendees were able to increase their understanding of technology, which indicates that a majority of attendees were able to gain new knowledge and skills related to robotics. Taking into account their prior knowledge of coding, which usually revolved around HTML or Scratch, this result is generally satisfactory.

Though the used programming language is generally regarded as low-level and hard to grasp for newcomers, the participants did not express any hardships with the caveats of the language, except the poor error messages which were in English; a language which not many were well acquainted yet. However, this feedback allowed us to put the results and our performance into perspective by matching them up with their satisfaction.

C. *Reflection on the workshops performance*

A reflection about the performance of a robotics and programming workshop is crucial for the organizers and tutors for multiple reasons. Firstly, reviewing what went well and what areas were in need of improvement ensures that the future participants reap the maximum benefit of it. Secondly, due to the gathered data in the post-workshop survey, we were able to determine the effectiveness of achieving the workshops intended objectives by comparing the pre-workshop interest in robotics and the average afterwards. Another metric used to measure our impact is the post-workshop analysis of one's aspiration for university and the rating given to us.

The organized workshops received a lot of positive feedback, both from the teachers as well as from the students, who rated it with an average of 4.6 out 5 stars, which confirmed our assumptions. In direct talks with the participants, we learned, that introducing new topics too quickly overwhelms them, which in turn decreases the understanding of the previous concepts. Therefore, we collected countermeasures to prevent introducing new topics too fast, such as, but not limited to:

- Awaiting direct audible feedback from the participants to introduce a new topic.
- Providing more examples to work with the current concepts.

- Giving them time to reflect on all the theories learned to this point.

Since we have yet to determine which countermeasure is the most effective, there is no data proving any of the options above.

Another critique was the choice of the programming language. Due to our experience in C and our assumptions leading us to think that C was an easy entry language for beginners, increased the difficulty of the course unnecessarily. Missing Semicolons or a value that was too large for an integer caused unexpected behavior that confused the participants. All of these mistakes could have been prevented by choosing another language such as Python [5] as the language of choice.

In upcoming workshops there might be switch to Python permanently, to avoid unwanted extra complexity from the course.

V. Conclusion

Notwithstanding the limitations of our workshop, specifically the rapid pace of instruction that may impede comprehension and the utilization of a complicated programming language with an excessive level of intricacy, it is worth emphasizing the favorable attributes. The program furnishes comprehensive elucidations and expert mentors who are capable of effectively communicating the course material, despite the obstacles. Acknowledging both the advantageous and disadvantageous facets of the workshop is vital as it allows us to recognize areas that require enhancement and implement the necessary modifications to better cater to the needs of our attendees.

As the hosts of this workshop, we had an overall pleasurable time interacting with the students and tutoring them in the area of our expertise. We believe, that nurturing the young minds of tomorrow with innovative workshops as these, is crucial to get them ready for the future. After all, the future appears to be both uncertain and exciting in the face of AI and robotics.

VI. Acknowledgments

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